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Prevalence and Rationale of Orthodontic Extractions at Loma Linda University

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School of Dentistry
in conjunction with the
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Prevalence and Rationale of Orthodontic Extractions
at Loma Linda University

by

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A thesis submitted in partial satisfaction of
the requirements for the degree of
Master of Science in Orthodontics and Dentofacial Orthopedics

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Each person whose signature appears below certifies that this thesis, in his opinion, is adequate in scope and quality as a thesis for the degree Master of Science.

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ABBREVIATIONS

ABO	American Board of Orthodontics
ALD	Arch Length Discrepancy
CBCT	Cone Beam Computed Tomography
ICC	Intraclass Correlation Coefficient
IIA	Interincisal Angle
L1-MP	Distance from Lower Incisor to Mandibular Plane
L1-NB	Distance from Lower Incisor to Nasion B line
LL-E	Lower Lip to E plane
Md	Mandible
Mx	Maxilla
OB	Overbite
OJ	Over jet
SD	Standard Deviation
STW	Sum of Tooth Widths
T1	Pre-treatment
T2	Post-Treatment
TSD	Tooth Size Discrepancy
U1- NA	Distance from Upper Incisor to Nasion A line
UL-E	Distance from Upper Lip to E-plane

ABSTRACT OF THE THESIS

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Master of Science in Orthodontics and Dentofacial Orthopedics
Loma Linda University, September 2015
Dr. Kitichai Rungcharassaeng, Chairperson

Aim: The purpose of this study was to determine the prevalence of orthodontic extraction cases and the rationale for the decision-making. **Materials & Methods**: The records of consecutive patients who had completed orthodontic treatment at Graduate Orthodontic Clinic, Loma Linda University School of Dentistry, between January 2010 and December 2014 were reviewed for prevalence of orthodontic extractions. Cone beam computed tomograms (CBCTs) of patients, that had extraction(s) prescribed as part of orthodontic treatment, were analyzed dentally and skeletally. Patients were then categorized according to the degree of crowding in each dental arch. A one-way ANOVA (Kruskal-Wallis) test and Mann Whitney U with Bonferroni adjustments for post-hoc pair-wise comparisons were used for statistical analysis at $\alpha = 0.05$. **Results:** There were 211 orthodontic extraction cases from 889 completed cases (23.7%). However, only 144 patients had sufficient records for further analysis in this study. Premolar extraction was prescribed in 134 patients (93.0%). Evaluation of each parameter based on degree of crowding revealed statistically significant differences in mandibular incisor to mandibular plane angle (L1-MP), interincisal angle, and maxillary incisor to Nasion-A point distance (U1-NA) [$p < 0.05$]. Furthermore, regardless of the degree of crowding, greater than 5 mm mandibular incisor to Nasion-B point distance (L1-NB) was observed in the majority of the cases (73.6%). **Conclusions:** Besides the degree of crowding, interincisal angle, L1-MP, U1-NA and L1-NB seem to be the determining factors in planning for orthodontic extraction cases.

CHAPTER ONE

REVIEW OF THE LITERATURE

Extraction for orthodontic correction has been and remains, a subject of great controversy. To extract or not, an irreversible procedure, is one of the most crucial aspects of treatment and while at the same time one of the most routine in orthodontic care.

Edward H. Angle once stated: "It is difficult to lay down any precise rule regarding extraction, but it is a matter which involves the broadest consideration, the closest study of each case, often taxing the judgment as much as does any problem in orthodontia. A rule which the author has followed for some time when at all in doubt, is to pursue treatment according to the conservative method, studying the relations of the dental arches carefully." [1] He also expressed an opinion that all 32 teeth could be accommodated in the jaws in ideal occlusion and Class I molar relationship. [2] Angle was consistent in his opposition to extractions and was convinced that bone is capable of forming around the teeth in their new positions without needing to resort to extraction of teeth.

Charles Tweed, a student of Angle's, challenged this viewpoint and developed a popular approach now referred to as the "Tweed Philosophy." He had grown frustrated with attempts to correct all malocclusion by either rounding out or expanding dental arches (usually in an anterior-posterior direction) while having to retreat a number of patients who suffered relapse. [2] He found that by treating all cases non-extraction, some resulted in collapse, irregular arches with intensified existing bimaxillary protrusion or creation of it when it did not previously exist. A collapse was particularly noted especially in the incisor region likely as a result of the teeth being positioned anterior to the medullary bone of the mandible. When the mesiodistal configurations of incisors were too large to be accommodated and well in the medullary bone, Tweed proposed extraction of first premolars as a solution.[3] Additionally, Tweed further emphasized extractions as a last resort only when the basal arches, the bone subjacent to the mandibular alveolar process or maxillary alveolar processes, were too constricted to permit normal arrangement of teeth without bringing these teeth beyond the medullary investing bone of their roots or positioning them in a procumbent position to the base of the mandible. [3]

Raymond Begg's approach to extractions arose from his observation of the contemporary Australian dentition in comparison to Aboriginal skulls. He noticed significant occlusal and interproximal wear and proposed that the modern Australian diet was not coarse enough to produce occlusal and interproximal wear.[16] Therefore, extraction of bicuspids was needed to compensate for this lack of interproximal wear.

William Proffit took an interest in the frequency of extractions in a paper published in April of 1994.[3] His study looked at consecutive charts at 5-year intervals from the orthodontic clinic at University of North Carolina. There was an initial increase in extractions that occurred between 1953-1963, which he attributed in part to the search for greater long-term stability. The subsequent decline from 1983-1993 was because of a greater concern that there would be an impact on facial esthetics and also that it actually does not guarantee stability and may even contribute to temporomandibular dysfunction.[3] In 1989, Weintraub et al. performed a telephone survey to quantify current orthodontic practice trends with respect to the extraction decision through a telephone survey study of all licensed orthodontists in Michigan.[3] The 238 respondents reported extraction rates that ranged from 5% to 87%. From the extremes that were reported, they selected five practices and found that the actual extraction rates ranged from 25% to 85%.[3] The researchers selected five practices from the reported extremes and found that a corrected and more accurate range was from 25% to 85%.[3] The ultimate conclusion was that a large discrepancy existed amongst orthodontists. A similar study by Perlow, et al. reported extraction rates measured between the years 1913-1979 and from 13 literature sources ranged from 6.5% to 83.5%.[1]

A survey of extraction patterns in hospital orthodontic services reported that the first premolars were the most commonly extracted (59%) followed by second premolars 13%, then first permanent molars (12%, and second permanent molars (7%).[5] The higher incidence of premolar extraction was attributed by its position within the dental arch as well as eruption pattern and as the option for allowing relief of anterior or posterior crowding.

When determining which teeth to extract, practitioners will tend to look at the quality and prognosis of teeth. For example, hypoplastic, abnormally formed, heavily restored, and carious teeth take precedence for removal in contrast to healthy teeth. [2] Dilacerated, geminated, fused and macrodont teeth typically need further assessment as they tend to have a chance of alignment but it is not always certain and long-term prognosis is often questionable.

When evaluating tooth shifting, it has been shown that extraction by itself cannot successfully correct malocclusion without the aid of orthodontic treatment thereafter. [23] Extractions do not typically achieve complete space closure through spontaneous tooth shifting after the extraction and cannot be relied on to correct crowding of teeth. Lack of treatment following extractions can contribute to periodontal disease, traumatic occlusion, and undesirable changes in facial profile.

More recently orthodontists have been reaching consensus when determining the need for extractions on a case-by-case basis. In a study conducted by Baumrind et al, the decision-making patterns of a representative group of orthodontic clinicians were examined. From a total of 740 patient evaluations and using five members of the UCSF clinical faculty, they found that in almost two thirds of the cases, the decisions of all five clinicians were in agreement for whether extraction or nonextraction was the preferred method of treatment.[2] In a second part to their investigation, they analyzed the stated reason behind their decisions. Crowding was cited as the primary reason in 49%, followed by incisor protrusion at 14%, need for profile correction at 8%, Class II severity in 5%, and achievement of a stable result in 5%.[2]

While some may view extractions as a feature of the “standard for care,” it is essential to have contemporary data on the prevalence of extraction cases. Because the decision making process for each treatment is based on a case-by-case basis, it would be advantageous to establish the general trend and factors that contribute to each decision.

CHAPTER TWO

PREVALENCE AND RATIONALE OF ORTHODONTIC EXTRACTIONS AT LOMA LINDA UNIVERSITY

Abstract

Aim: The purpose of this study was to determine the prevalence of orthodontic extraction cases and the rationale for the decision-making. **Materials & Methods**: Consecutive patients who completed orthodontic treatment at Graduate Orthodontic Clinic, Loma Linda University School of Dentistry, between January 2010 and December 2014 were reviewed for prevalence of orthodontic extractions. Cone beam computed tomograms (CBCTs) of patients, that had extraction(s) prescribed as part of orthodontic treatment, were analyzed dentally and skeletally. Patients were then categorized according to the degree of crowding in each dental arch. A one-way ANOVA (Kruskal-Wallis) test and Mann Whitney U with Bonferroni adjustments for post-hoc pair-wise comparisons were used for statistical analysis at $\alpha = 0.05$. **Results:** There were 211 orthodontic extraction cases from 889 completed cases (23.7%). However, only 144 patients had sufficient records for further analysis in this study. Premolar extraction was prescribed in 134 patients (93.0%). Evaluation of each parameter based on degree of crowding revealed statistically significant differences in mandibular incisor to mandibular plane angle (L1-MP), interincisal angle, and maxillary incisor to Nasion-A point distance (U1-NA) [$p < 0.05$]. Furthermore, regardless of the degree of crowding, greater than 5 mm mandibular incisor to Nasion-B point distance (L1-NB) was observed in the majority of the cases (73.6%). **Conclusions:** Besides the degree of crowding, interincisal angle, L1-MP, U1-

NA and L1-NB seem to be the determining factors in planning for orthodontic extraction cases.

Introduction

Extraction for orthodontic correction has been and remains, a subject of great controversy. To extract or not, an irreversible procedure, is one of the most crucial aspects of treatment and while at the same time one of the most routine in orthodontic care.

Edward H. Angle believed in approaching treatment conservatively and studied the relations of the dental arches carefully.[1] He stated that all 32 teeth could be accommodated in the jaws in ideal occlusion and Class I molar relationship.[2] Angle was highly opposed to extractions and was convinced that bone is capable of forming around the teeth in their new positions without needing to resort to extraction of teeth.[1]

Charles Tweed, a student of Angle's, challenged this viewpoint and developed a popular approach now referred to as the "Tweed Philosophy." He became frustrated with attempting to correct all malocclusions by either rounding out or expanding dental arches and having to retreat a number of patients who suffered relapse.[2] By treating all cases non-extraction, some resulted in collapse, irregular arches with intensified existing bimaxillary protrusion or creation of it when it did not previously exist. This "collapse" was particularly noted in the incisor region mainly as a result of teeth being positioned anterior to the medullary bone of the mandible.[2] When the mesiodistal configurations of incisors were too large to be accommodated in the medullary bone acceptably, Tweed proposed extraction of first premolars as a solution.[3] In addition, Tweed emphasized extraction should be used as a last resort only when the basal arches, the bone subjacent to the mandibular alveolar process or maxillary alveolar processes, were too constricted to permit normal arrangement of teeth without bringing these teeth beyond the medullary investing bone of their roots or positioning them in a procumbent position to the base of the mandible.[2]

William R. Proffit took an interest in the frequency of extractions, publishing a paper in April of 1994.[3] His study looked at consecutive charts at 5-year intervals from the orthodontic clinic at University of North Carolina. There was an initial increase in extractions that occurred between 1953-1963 and was due in part to the search for greater long-term stability.[3] The decline subsequently from 1983-1993 was because of a greater concern that there would be an impact on facial esthetics and also that it actually does not guarantee stability and may even cause temporomandibular dysfunction.[4]

In a survey of extraction patterns in hospital orthodontic services, it was shown that first premolars were the most commonly extracted at 59%.[5] Second premolars were next at 13%, first permanent molars at 12%, and second permanent molars at 7%.[5] The higher incidence of premolar extraction was attributed by its position within the dental arch as well as eruption pattern and as the option for allowing relief of anterior or posterior crowding.

Recently, there has been more agreement amongst orthodontic clinicians when determining the need for extractions on a case-by-case basis. In a study conducted by Baumrind, Korn, Boyd, and Maxwell, the decision-making patterns of a representative group of orthodontic clinicians were examined.[6] Crowding was cited as the primary reason in 49%, followed by incisor protrusion at 14%, need for profile correction at 8%, Class II severity in 5%, and achievement of a stable result in 5%.[6]

While some may view extractions as a feature of the “standard for care,” it is essential to have contemporary data on the prevalence of extraction cases. Because the decision making process for each treatment is based on a case-by-case basis, it would be advantageous to establish the general trend and factors that contribute to each route.

The purpose of this study was to determine the prevalence and factors associated with tooth extraction in orthodontic treatment in the Graduate Orthodontic Clinic, Loma Linda University School of Dentistry (LLUSD).

Materials and Methods

This study was reviewed and approved by the Institutional Review Board of Loma Linda University. To determine the prevalence of extractions, the pre-treatment (T1) and post-treatment (T2) panoramic radiographs of consecutive patients who had completed orthodontic treatment at the Graduate Orthodontic Clinic, LLUSD from January 2010 to December 2014 were reviewed and the following information recorded:

1. Chart Number
2. Sex (male or female)
3. Race (White, Black, Asian, Hispanic, other)
4. Age at start of treatment (in year-month)
5. Age at end of treatment (in year-month)
6. Total length of treatment
7. Extractions or non-extraction treatment performed (Third Molar extractions were not considered for further extraction case evaluation)

Patients with craniofacial anomalies or skeletal deformities were not included in the study. For patients that had extraction(s) prescribed as part of orthodontic treatment with available T1 Cone Beam Computed Tomography (CBCT) and lateral cephalometric records, the following additional information was collected.

1. The tooth/teeth that was/were extracted
2. T1 orthodontic measurements of dental, skeletal, soft tissue, and reason for extractions were recorded. CBCT records were viewed on OsiriX (OsiriX v. 5.6 32-bit) and lateral cephalograms analyzed on Dolphin 3D Imaging (Dolphin Imaging & Management Solutions)
3. T1 arch length discrepancy (ALD) and tooth size discrepancy (TSD) from evaluation of CBCT records viewed and measured on Osirix (OsiriX v. 5.6 32-bit).

Sagittal dental, skeletal and soft tissue relationship

1. Molar relationship (Figure 1).
    a. B1-B2: Full Cusp Class II- mesiobuccal cusp of the maxillary first molar occluding anterior to the mesial marginal ridge of the mandibular first molar.
    b. B2-B3: End to End Class II- mesiobuccal cusp of the maxillary first molar occluding between the buccal groove and the mesial marginal ridge of the mandibular first molar
    c. B3-B4 Class I- mesiobuccal cusp of the maxillary first molar occluding in line with the buccal groove of the mandibular first molar.
    d. B4-B5 End to End Class III- mesiobuccal cusp of the maxillary first molar occluding between the distal marginal

ridge and posterior to the buccal groove of the mandibular first molar.

e. B5-B6 Full Cusp Class III- mesiobuccal cusp of the maxillary first molar occluding posterior to the distal marginal ridge of the mandibular first molar.

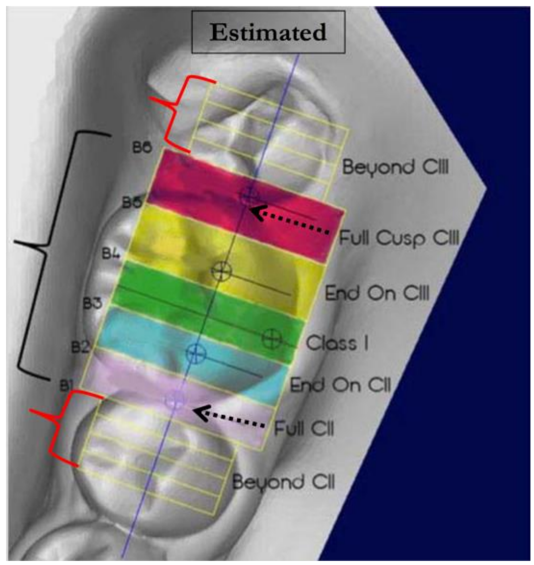

Figure 1: Molar relationship diagram as defined by the American Board of Orthodontics (ABO).

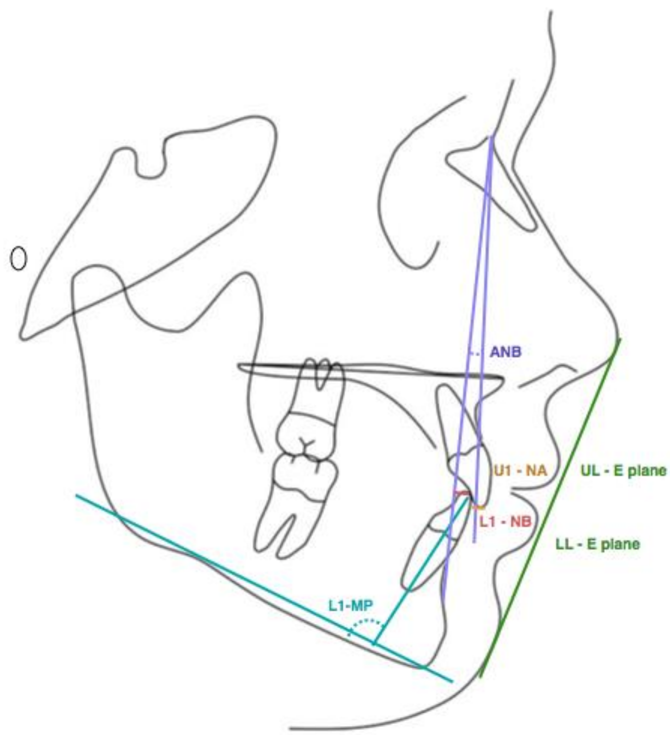

Figure 2: Steiner Angles and Measurements for L1-MP, ANB, U1-NA, L1-NB, UL- E Plane, and LL- E Plane.

2. L1-MP (Norm: 90° ± 5°).[7] Lower incisor (L1) angulation/proclination to the mandibular plane (MP) to be measured from the long axis of the tooth (from the incisal edge to the center of the apex) to the mandibular plane as defined by the ABO (Figure 2).

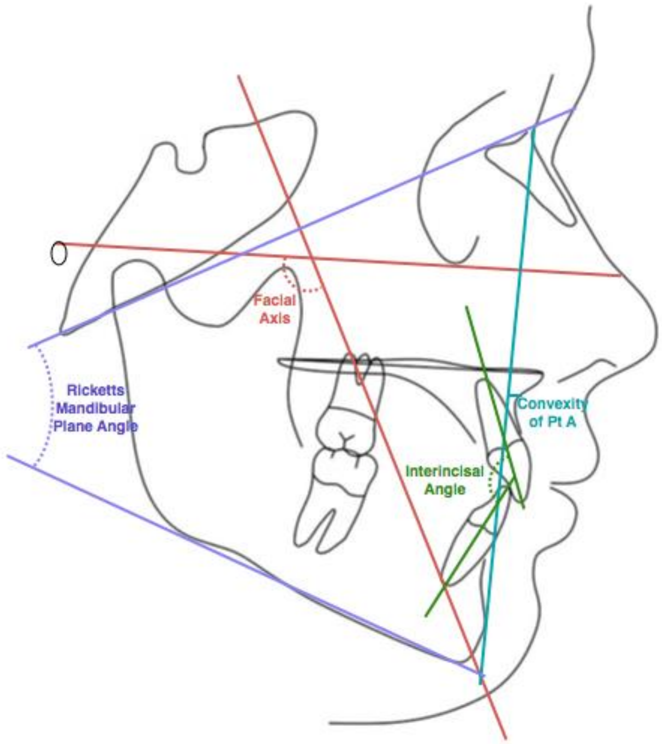

Figure 3: Ricketts Angles and Measurements for Convexity of Point A, Interincisal Angle, Ricketts Mandibular Plane Angle, and Facial Axis.

3. Skeletal convexity of point A (Norm: 2 ± 2 mm).[7] Facial convexity is the distance in millimeters from A point to the facial plane, when measured perpendicular to that plane (Figure 3).
4. ANB (Norm: 2 ± 2 mm).[7] A-point-Nasion-B-point (ANB) angle measures the relative position of the maxilla to mandible (Figure 2). The ANB angle can be measured or calculated from the formula: ANB = Sella-Nasion-A-point angle (SNA) – Sella-Nasion-B-point angle (SNB). An ANB between 0-4 indicates a Class I skeletal relationship. ANB values greater than 4 indicates that the maxilla is positioned anteriorly relative to the mandible (Class II). A negative

ANB angle indicates that the maxilla is positioned posteriorly relative to the mandible (Class III malocclusion cases).

5. Interincisal angle (IIA) [Norm: 135° ± 11°].[8] The interincisal angle is to be measured at the point of intersection of the long axes of the upper and lower incisors (Figure 3). This differs from Bolton in that it is a value taken from the cephalogram and revolves around the long axis of the entire tooth as opposed to the coronal long axis.
6. OJ (mm). Distance from the upper central incisor tip to a plane tangential to the lower incisor labial surface and parallel to the occlusal plane (Figure 4). As per the ABO, OJ is to be measured between "two antagonistic anterior teeth (lateral or central incisors) comprising the greatest overjet and is measured from the facial surface of the most lingual mandibular tooth to the middle of the incisal edge of the more facially positioned maxillary tooth."
7.

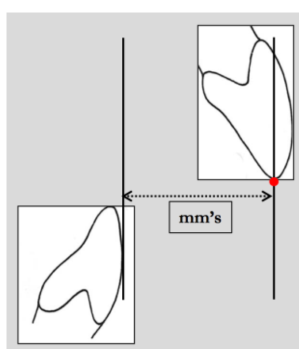

Figure 4: Overjet (OJ) diagram as defined by the American Board of Orthodontics (ABO).

8. Upper Central Incisor to NA (Norm: 3 ± 2 mm).[7] Distance from upper incisor tips to Na-A line (Figure 2).
9. Lower Central Incisor to NB (Norm: 3 ± 2 mm).[7] Distance from the lower incisor to Na-B line (Figure 2).
10. UL-E (Norm: -2 ± 2 mm).[8] Upper lip protrusions; distances from upper lip to E-plane and from lower lip to E-plane (Figure 2).
11. LL-E (Norm: -2 ± 2 mm).[8] Lower lip protrusions; distances from upper lip to E-line and from lower lip to E-line, respectively (Figure 2).

<u>Vertical dental and skeletal relationship</u>

1. Ricketts Mandibular Plane Angle (Norm: $26 \pm 4°$).[7] Formed by the intersection of the Frankfort horizontal plane and the mandibular plane (Figure 3).
2. Facial Axis (Norm: $90° \pm 3°$).[7] Pterygomaxillary fissure (PTM) point to gnathion (Figure 3).
3. OB (mm). Distance between two antagonistic teeth comprising greatest overbite, perpendicular to the occlusal plane. (As defined by the ABO, Figure 5)

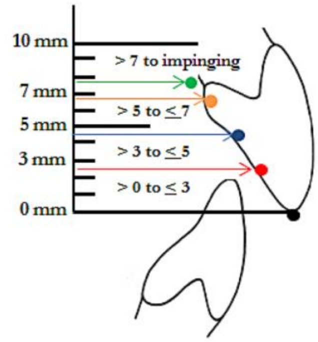

Figure 5: Overbite (OB) diagram as defined by the American Board of Orthodontics (ABO).

Arch length discrepancy (ALD) and tooth size discrepancy (TSD)

1. Sum of Tooth widths (STW in mm). The sum of the mesiodistal crown widths from canine to canine (STW_{3-3}) and from 1st molar to 1st molar (STW_{6-6}) will be recorded. (Figure 6)
2. Arch Length (AL in mm). Modified irregularity indices for the upper and lower dentitions, respectively. Sum of the linear distances from an anatomic contact point to its adjacent anatomic contact point between the first molar tooth on one side and in each dental arch on the opposite side. [8] (Figure 7)
3. Arch Length Discrepancy (ALD in mm) = AL – STW_{6-6}. Negative values denote crowding and positive values denote spacing in the arch.
4. Tooth Size Discrepancy (TSD in mm). The ratio of $MxSTW_{3-3}/MdSTW_{3-3}$ and $MxSTW_{6-6}/MdSTW_{6-6}$ will be calculated and compared to the norms (Norms: $MxSTW_{3-3}/MdSTW_{3-3}$ = 77.2%;

MxSTW$_{6-6}$/MdSTW$_{6-6}$ = 91.3%). The percentage discrepancy from the norm will be converted to mm and expressed as TSD.

All data collection and measurements were performed by 1 examiner.

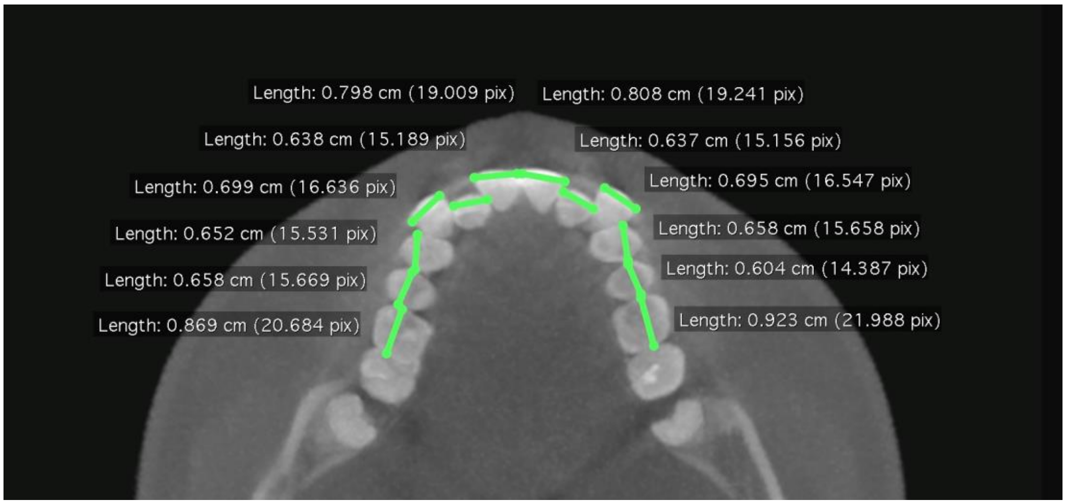

Figure 6: CBCT measurements on Osirix to determine the sum of tooth widths.

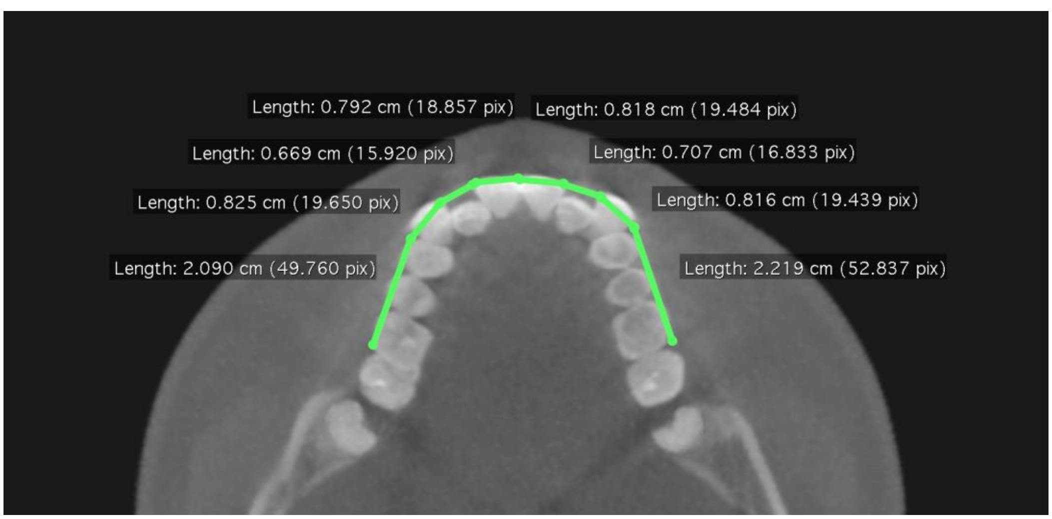

Figure 7: CBCT measurements on Osirix to determine the arch length.

Statistical Analysis

All statistical analysis was performed using SAS version 9.3 computer software (SAS Institute Inc., Cary, North Carolina). Statistical analysis included means, standard deviations, and ranges calculated for each variable.

Comparison of each parameter according to the degree of crowding in each arch was performed using a one-way ANOVA (Kruskal-Wallis Test) and Mann Whitney U with Bonferroni adjustments for post-hoc pair-wise comparisons at $\alpha = 0.05$.

An intraclass correlation coefficient (ICC) was used to determine intra-examiner reliabilities using double measurements of each parameter made 2 weeks apart on 30 randomly selected cases using a research randomizer software.[9]

Results

From the records of 889 patients who had completed orthodontic treatment between January 2010 and December 2014, 211 (23.7%) were prescribed with orthodontic extraction. Out of the 211 extraction cases, 144 had complete T1 CBCT and lateral cephalometric records and were further analyzed to determine the number and type of teeth extracted and the rationale for extraction. The frequency distribution of each type of extraction is shown in Figure 8. The most common extraction scenario was the extraction of 4 first premolars (51/144; 35.4%), followed by extraction of maxillary premolars only (27/144; 18.8%). The extraction of premolars was observed in 93.0% (134/144) of the cases.

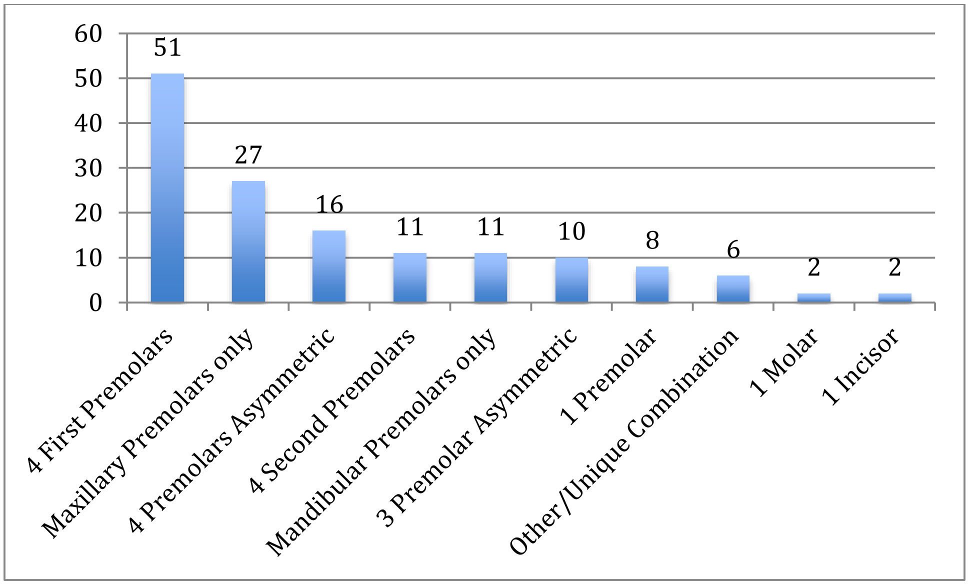

Figure 8: Frequency distribution of type of extraction. 144 cases were represented.

Table 1: Intraexaminer reliabilities test expressed as an ICC.

Parameter	Intraclass Correlation
ALD (Maxilla)	0.998
ALD (Mandible)	0.998
Convexity of Point A	0.996
Facial Axis	0.979
Interincisal Angle	0.996
L1-NB	0.998
L1-MP	0.991
LL- Eplane	0.997
OB	0.988
OJ	0.990
Ricketts Md Plane	0.987
TSD (6-6)	0.966
U1-NA	0.992
UL - Eplane	0.997

The frequency distribution of patients according to the degree of crowding in each arch is shown in Table 2. Summary of comparisons (Kruskal Wallis test) of each parameter according to the degree of crowding is shown in Table 3. Only L1-MP, interincisal angle, and U1-NA showed statistically significant differences ($p<0.05$;Table 3) among the groups and further analyses (Mann Whitney U test with Bonferroni adjustments) shown in Tables 4-6 respectively. The data of parameters that did not result in statistically significant differences can be found in appendix A.

Table 2: Frequency distribution according to the degree of crowding in each arch.

		Maxilla			
		Mild	Moderate	Severe	Total
Mandible	Mild	36	16	15	67
	Moderate	19	12	13	44
	Severe	6	14	13	33
	Total	61	42	41	144

N = 144

Table 3: Summary of comparisons of each parameter according to the degree of crowding using Kruskal Wallis test at α = 0.05

	Means ± SD				
	Norm	**Mean**	**Lowest Value** $^{\Phi}$	**Highest Value** $^{\Psi}$	**P-value**
L1-MP	90° ± 5°	95.2 ± 7.1	91.5 ± 7.4	98.1 ± 6.6	0.004*
ANB	2 ± 2 mm	4.4 ± 2.8	3.0 ± 3.5	5.1 ± 3.2	0.338
Convexity of Point A	2 ± 2 mm	3.9 ± 3.0	2.7 ± 3.3	4.6 ± 2.5	0.483
Interincisal Angle	135° ± 11°	122.7 ± 11.5	116.2 ± 8.6	124.7 ± 9.1	0.008*
OJ	2.5 ± 2.5 mm	4.3 ± 2.8	2.9 ± 3	5.8 ± 2.8	0.054
U1-NA	3 ± 2 mm	5.1 ± 3.2	3.0 ± 3.4	7.7 ± 4.2	0.042*
L1-NB	3 ± 2 mm	6.9 ± 3.1	5.7 ± 2.1	7.9 ± 2.8	0.393
UL to E-Plane	-2 ± 2 mm	-1.3 ± 3.3	-2.4 ± 4	0.1 ± 3.4	0.418
LL to E-Plane	-2 ± 2 mm	-1.3 ± 3.3	-0.4 ± 3.7	2.9 ± 4.1	0.080
Ricketts Md Plane	30° ± 4°	31.2 ± 6.2	29.2 ± 2.4	33.5 ± 6.2	0.722
Facial Axis	90° ± 3°	86.3 ± 8.3	83.4 ± 4.6	89.6 ± 3.1	0.325
OB	2.5 ± 2 mm	1.9 ± 2.3	0.9 ± 2.6	3.6 ± 2.7	0.171
TSD 6-6	91.30%	92.3 ± 1.5	91.0 ± 2.6	94.1 ± 6.1	0.052
TSD 3-3	77.20%	78 ± 2.1	77.6 ± 1.8	81.7 ± 5.2	0.683

N = 144
* Statistically significant difference result
$^{\Phi}$ Represents the means of the lowest group
$^{\Psi}$ Represents the means of the highest group

Table 4: Comparison of L1-MP according to the degree of crowding using Kruskal Wallis test and post-hoc pair-wise comparisons conducted using Mann Whitney U test with Bonferroni adjustments at α = 0.05.

		Mean ± SD of L1-MP (°) [Range]			
		Maxilla			
		Mild	Moderate	Severe	Total
Mandible	Mild	98.1 ± 6.6^{a} [82.5 - 114.6]	96.5 ± 5.2^{a,b} [87.8 - 104.7]	96.2 ± 5.4^{a,b} [88.8 - 105.1]	97.3 ± 6.0 [82.5 - 114.6]
	Moderate	96.9 ± 8.0^{a,b} [81.2 - 108.2]	93.7 ± 4.9^{a,b} [86 - 104.2]	92.4 ± 7.3^{a,b} [78.3 - 102.5]	94.7 ± 7.2 [78.3 - 108.2]
	Severe	89.2 ± 4.9^{a,b} [83.6 - 97.1]	93.7 ± 6.0^{a,b} [78.3 - 103.1]	91.5 ± 7.4^{b} [71.4 - 108]	91.5 ± 7.4 [71.4 - 108]
	Total	96.9 ± 7.3 [81.2 - 114.6]	94.7 ± 5.5 [78.3 - 104.7]	93.1 ± 7.6 [71.4 - 108]	

Sig. p = 0.004

^{a,b} Different letters indicate statistically significant differences

Table 5: Comparison of Interincisal angle according to the degree of crowding using Kruskal Wallis test and post-hoc pair-wise comparisons conducted using Mann Whitney U test with Bonferroni adjustments at α = 0.05.

		Mean ± SD of Interincisal Angle (°) [Range]			
		Maxilla			
		Mild	Moderate	Severe	Total
Mandible	Mild	116.2 ± 8.6^{a} [102.4 - 137.5]	121.8 ± 10.7^{a,b} [103 - 140.7]	124.7 ± 9.1^{a,b} [106.5 - 140.2]	119.5 ± 9.8 [102.4 - 140.7]
	Moderate	121.5 ± 11.9^{a,b} [97.6 - 148.3]	121.9 ± 8.0^{a,b} [105.5 - 138.4]	124.5 ± 12.4^{a,b} [106.3 - 149.7]	122.5 ± 10.9 [97.6 - 149.7]
	Severe	129.1 ± 13.6^{a,b} [113.6 - 151.8]	121.5 ± 13.3^{a,b} [90.9 - 145.1]	131.4 ± 13.4^{b} [109.1 - 155]	126.8 ± 13.8 [90.9 - 155]
	Total	119.1 ± 10.9 [97.6 - 151.8]	121.8 ± 10.8 [90.9 - 145.1]	126.8 ± 11.8 [106.3 - 155]	

Sig. p = 0.008

^{a,b} Different letters indicate statistically significant differences

Table 6: Comparison of U1-NA according to the degree of crowding using Kruskal Wallis test and post-hoc pair-wise comparisons conducted using Mann Whitney U test with Bonferroni adjustments at $\alpha = 0.05$.

		Mean ± SD of U1-NA (mm) [Range]			
		Maxilla			
		Mild	Moderate	Severe	Total
Mandible	Mild	$5.9 \pm 2.2^{a,b}$ [2 - 11.1]	$4.6 \pm 3.1^{a,b}$ [0.9 - 9.9]	$4.5 \pm 2.8^{a,b}$ [1.4 - 9.6]	5.3 ± 2.6 [0.9 - 11.1]
	Moderate	$5 \pm 3.2^{a,b}$ [-0.9 - 11.8]	$4.6 \pm 1.9^{a,b}$ [1.8 - 7.4]	$5.0 \pm 4.3^{a,b}$ [2.2 - 11.4]	4.9 ± 3.2 [-4.8 - 11.8]
	Severe	$4.3 \pm 2.3^{a,b}$ [0.8 - 7]	7.7 ± 4.2^{a} [2.2 - 16.3]	3.0 ± 3.4^{b} [-2.8 - 9]	5.2 ± 4.1 [-2.8 - 16.3]
	Total	5.5 ± 2.5 [-0.9 - 11.8]	5.6 ± 3.5 [0.9 - 16.3]	4.2 ± 3.5 [-4.8 - 11.4]	

Sig. p = 0.042

^{a,b} Different letters indicate statistically significant differences

Discussion

The prevalence of orthodontic extraction cases (23.7%) at LLUSD was about average in comparison to previously published studies.[1,3,10] In Proffit's forty-year evaluation of extraction frequencies, he noted that the rate of extraction was 30% in 1953, peaked at 76% in 1968, and declined again to 28% in 1993.[3] A study conducted by Weintraub using a telephone survey of 238 licensed orthodontists showed that extraction rates ranging from 5% to 87%.[10]

Out of the 144 extraction cases, 134 of them involved premolar extractions (Figure 8). The most common type was extraction of all 4 first premolars, which was represented with 51 cases (35.4%) followed by 27 cases in which there were only single arch extraction of maxillary premolars (18.8%). This result was not surprising as this is typically expected for orthodontic extractions. In previous studies looking at extraction patterns in hospital orthodontic services, the results showed that first premolars were the most commonly extracted (59%), followed by second premolars (13%), first molars (12%) and lastly second molars (7%).[11] In reference to Proffit's study, he noted that the changes in extraction frequencies were mostly due to an increase followed by a subsequent decrease in extraction of the four first premolars.[3] The reasoning, he believed, was from differing esthetic guidelines, long-term studies of stability, and consideration for temporomandibular dysfunction as well as technique changes.[3]

To evaluate the reasons for extractions that were not one of the parameters used in the study, the charts of each case was reviewed and the documented reasons were noted. Extraction of molars was typically due to periodontal defects and for incisors it was to relieve crowding. For unilateral extractions, the charts indicated skeletal asymmetries or unilateral Class II molar relationships. The removal of upper first bicuspids was usually attributed to relieving excess over jet. With extraction of second bicuspids over first bicuspids, documentation suggests it was to relieve crowding and still maintain the incisor position to avoid compromising the profile. Extraction of upper and lower first bicuspids was most often associated with crowding and blocked out cuspids. Occasionally with asymmetric four bicuspid extractions, it was attributed to caries and non-restorable bicuspids.

It is evident that throughout history, the indications for orthodontic extractions have been a subject of controversy. [1,2,12] To help further explore these indicators, this study sought to analyze each measurement and compare within the cohort to determine trends. It is obvious that one of the main predicators for warranting orthodontic extractions is the degree of crowding. Bishara et al reported that crowding was the most significant factor influencing the extraction decision. [12] In addition, Saelens and De Smit also stated that pretreatment crowding was twice as great in the first premolar extraction group compared with the second premolar extraction group.[12] In another investigation by Gianelly et al. of 542 randomly selected Class I patients, the most important factor found for extraction in borderline cases was lower crowding. [13] They concluded that the extraction decision should be based on crowding in the lower arch since the alteration of the perimeter and intercanine widths should be avoided. [13] An interesting result of this study was that the majority of the extraction cases had mild crowding in both arches. Out of the 144 cases, 36 of them (25.0%) had mild crowding which was the highest frequency out of all the groups. This was surprising because although crowding is typically associated as being the primary reasons for warranting extraction, the results of this sample size showed that other parameters could warrant extraction even in cases with mild crowding.

To better analyze the entirety of the data in this study, the level of crowding in each arch was assessed and each factor was compared to determine which factors were more significant. The results of the study showed that the factors that showed a statistically significant differences among the groups L1-MP ($p = 0.004$; Table 4), and IIA ($p = 0.008$; Table 5), and U1-NA ($p = 0.042$; Table 6). The fact that L1-MP of the mild-mild group (98.1°) was significantly more obtuse than that of the severe-severe group (91.5°) [p=0.004; Table 4] means that L1 is more proclined in mild-mild situations. Similar results were observed with IIA, where IIA of mild-mild group (116.2°) was significantly more acute than that of severe-severe group (131.4°) [p=0.008; Table 5]. This implies that U1 and/or L1 is/are more proclined in mild-mild situations. Downs proposed that the interincisal angle should be at 135.4° and Steiner also proposed that the interincisal angle should be at 131°.[14] It is appropriate then to propose orthodontic extractions for cases with mild crowding in both arches with low IIA and/or high L1-MP to better normalize the IIA and L1-MP. Kocadereli et al, showed that extraction of maxillary and mandibular first premolars resulted in a mean increase of the IIA of about 4.5° which helped normalize the angle.[12]

Although statistically U1-NA of severe-severe group (3.0 mm) was only significantly lower than that of moderate-severe group (7.7 mm) [p=0.042; Table 6], it was clinically lower than all other groups (4.3-5.9 mm; Table 6) too. It is also noteworthy that although the L1-NB results did not show statistically different values between the groups, regardless of the degree of crowding, the means of L1-NB of all groups (5.7-7.9 mm) were greater than one standard deviation from the norm of (3 ± 2.0 mm; Table 2). The majority of the cases (73.6%) showed a L1-NB value greater than 5 mm with an overall mean of 6.9 mm (Table 2). There results suggest that angulation/inclination, both U1 and L1 positions are of prognostic value for extraction cases.

Previous studies looking at extraction decisions have reported that variables such as over jet, molar relationship, vertical facial pattern, and tooth-size discrepancies were the most significant influencers.[14] It is worthwhile to note that in this particular data set, none of those factors aside from molar relationship showed any significant differences when evaluating based on crowding in each arch with most overall mean values within one SD from the norm (Table 3). These variables are still important to the extraction decision but for this study, the incisor position showed the most significance when evaluating based on crowding.

For most orthodontic clinicians, the treatment plan revolves around where the final position of the anterior teeth will be in relationship to the face followed by the establishment of a stable occlusion. [15] Diagnostic Triangles, [2] Chevrons, [14] A-Pogonion (A-Po) line, [7] and Holdaway line[7] were all used as a guide to establish proper incisor position and angulation/inclination. The results of this study confirm that besides the degree of crowding, incisor position and angulation/inclination are important determining factors for treatment planning for extractions.

Conclusions

Within the limits of this study, the following conclusions could be made:

1. From January 2010 to December 2014, the prevalence of orthodontic extractions at Loma Linda University was 23.7%.
2. Out of 144 cases, 93.0% of them involved premolar extraction. . The most common extraction scenario was the extraction of 4 first premolars (51/144; 35.4%), followed by extraction of maxillary premolars only (27/144; 18.8%).
3. Besides the degree of crowding, interincisal angle, L1-MP, U1-NA and L1-NB seem to be the determining factors in planning for orthodontic extraction cases.

CHAPTER THREE

EXTENDED DISCUSSION

Study Improvements and Future Discussion

This study was limited by the small sample size of patients with complete CBCT records. A similar study could be done looking at both pre-treatment (T1) and post-treatment (T2) records. By looking at post-treatment results, a better understanding of the outcome and finish of the cases treated with extractions can be assessed. Future studies can be done to determine which parameters were most significant in T1 records that resulted in better finishes determined from T2 records. It would be interesting to know if extraction of premolars in only one arch instead of both affected the finish and treatment time. Perhaps, getting data from a controlled Class II sample from a known growth center would also be of value. From this data, it would be clinically beneficial to look at the decision points and also determine where the extraction/non-extraction tipping point is with Class II patients.

The original plan of the study was to evaluate models of T1 records to assess molar relationship, and arch length discrepancy. There was inconsistency with records available for each patient so the decision was made to obtain these measurements through use of the T1 CBCT scans on OsiriX.

Some study limitations include the possibility of other extraneous factors that may have influenced the decision to extract that were not one of the parameters. These limitations could range from parents who prefer extraction instead of expansion or patients with compromised periodontium or carious lesions.

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Appendix

Table 7: Means and standard deviations for ANB organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of ANB (°) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	4.8 ± 2.2 [0 - 9]	4.8 ± 2.9 [-1 - 10]	4.2 ± 2.3 [0 - 8]	4.7 ± 2.4 [-1 - 10]
	Moderate	5.1 ± 3.2 [-3 - 10]	5.3 ± 2.2 [1 - 9]	3.0 ± 3.5 [-3 - 9]	4.5 ± 3.2 [-3 - 10]
	Severe	3.8 ± 2.3 [0 - 6]	3.6 ± 3.3 [-3 - 10]	4.2 ± 3.3 [0 - 12]	3.8 ± 3.1 [-3 - 12]
	Total	4.8 ± 2.5 [-3 - 10]	4.5 ± 2.9 [-3 - 10]	3.8 ± 3 [-3 - 12]	

Sig. p = 0.338

Table 8: Means and standard deviations for convexity of point A organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of Convexity of Point A (mm) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	4.6 ± 2.5 [0.3 - 12.1]	4.2 ± 3.3 [-0.9 - 10.4]	3.6 ± 2.8 [-0.8 - 7.8]	4.3 ± 2.8 [-0.9 - 12.1]
	Moderate	4.4 ± 3.3 [-3.6 - 10.7]	4.3 ± 2.7 [-2 - 8.3]	2.8 ± 3.4 [-3 - 9.1]	3.9 ± 3.2 [-3.6 - 10.7]
	Severe	2.8 ± 2 [-0.1 - 5.7]	2.7 ± 3.3 [-4.2 - 8.5]	3.9 ± 3.6 [-1.2 - 13.2]	3.2 ± 3.2 [-4.2 - 13.2]
	Total	4.3 ± 3 [-3.6 - 12.1]	3.8 ± 3.2 [-4.2 - 10.4]	3.5 ± 3.2 [-3 - 13.2]	

Sig. p = 0.483

Table 9: Means and standard deviations for overjet organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of OJ (mm) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	4.8 ± 2.5 [-0.5 - 9.9]	3.8 ± 2.8 [-1.6 - 9.7]	3.4 ± 3.2 [-3.1 - 9.2]	4.2 ± 2.8 [-3.1 - 9.9]
	Moderate	4.6 ± 3.0 [-2.2 - 12.8]	5.4 ± 1.9 [2.4 - 9.9]	2.9 ± 3.0 [-4.3 - 7.2]	4.3 ± 2.9 [-4.3 - 12.8]
	Severe	3.7 ± 1.9 [1 - 6]	5.8 ± 2.8 [2.5 - 11.7]	3.2 ± 2.6 [-0.6 - 7.7]	4.4 ± 2.8 [-0.6 - 11.7]
	Total	4.6 ± 2.6 [-0.2 - 12.8]	4.9 ± 2.7 [-1.6 - 11.7]	3.2 ± 2.9 [-4.3 - 9.2]	

Sig. p = 0.054

Table 10: Means and standard deviations for lower incisor to NB (L1-NB) organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of L1-NB (mm) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	7.9 ± 2.8 [2.7 - 13.5]	7.3 ± 3.1 [2.6 - 12.3]	6.9 ± 2.7 [3.2 - 14]	7.6 ± 2.8 [2.6 - 14]
	Moderate	7.6 ± 3.9 [1.8 - 16.8]	6.3 ± 2.5 [1.8 - 11]	6.2 ± 3.3 [-1.1 - 11.6]	6.8 ± 3.4 [-1.1 - 16.8]
	Severe	5.7 ± 2.1 [2.9 ± 8.5]	6.1 ± 2.3 [-0.3 - 8.9]	6.1 ± 3.8 [1 - 14.5]	6 ± 2.9 [-0.3 - 14.5]
	Total	7.6 ± 3.2 [1.8 - 16.8]	6.6 ± 2.7 [-0.3 - 12.3]	6.4 ± 3.2 [-1.1 - 14.5]	

Sig. p = 0.393

Table 11: Means and standard deviations for upper lip to esthetic plane (UL to E-plane) organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of UL to E-plane (mm) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	-0.8 ± 3.8 [-13.8 - 7.6]	-1.8 ± 2.7 [-7.7 - 2.9]	-1.8 ± 3.3 [-8.7 - 1.9]	-1.2 ± 3.4 [-13.8 - 7.6]
	Moderate	0.1 ± 3.4 [-6.6 - 6.8]	-1.4 ± 1.9 [-4.7 - 1.2]	-2.4 ± 4.0 [-9.8 - 4.5]	-1 ± 3.3 [-9.8 - 6.8]
	Severe	-1.8 ± 2.6 [-5.1 - 2.2]	-1.1 ± 3.0 [-6.7 - 4.8]	-2.4 ± 2.8 [-7.4 - 2]	1.7 ± 2.8 [-7.4 - 4.8]
	Total	-0.6 ± 3.5 [-13.8 - 7.6]	-1.4 ± 2.6 [-7.7 - 4.8]	-2.2 ± 3.3 [-9.8 - 4.5]	

Sig. p = 0.418

Table 12: Means and standard deviations for lower lip to esthetic plane (LL to E-plane) organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of LL to E-plane (mm) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	2.0 ± 3.7 [-7.6 - 8.5]	0.4 ± 3.2 [-5.1 - 5.2]	0.4 ± 3.7 [-6.6 - 6.8]	1.3 ± 3.6 [-7.6 - 8.5]
	Moderate	2.9 ± 4.1 [-7 - 10.2]	0.4 ± 2.3 [-4 - 4.7]	-0.4 ± 3.7 [-8 - 5.4]	1.3 ± 3.8 [-8 - 10.2]
	Severe	0.4 ± 1.4 [-2.1 - 1.5]	0.4 ± 2.8 [-3.9 - 5]	0.0 ± 3.6 [-5.4 - 6.4]	0.2 ± 2.9 [-5.4 - 6.4]
	Total	2.2 ± 3.7 [-7.6 - 10.2]	0.4 ± 2.8 [-5.1 - 5.2]	0.0 ± 3.6 [-8 - 6.8]	

Sig. p = 0.080

Table 13: Means and standard deviations for ricketts mandibular plane organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

Sig. p = 0.722		**Mean ± SD of Ricketts Md Plane (°) [Range]**			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	30.4 ± 7.4 [15.4 - 43.4]	32.6 ± 5.5 [25.8 - 43.8]	32.1 ± 5.8 [23.1 - 45.9]	31.3 ± 6.6 [15.4 - 45.9]
	Moderate	30.6 ± 6.4 [20 - 46.7]	31 ± 6.7 [19 - 47.3]	31.3 ± 4.8 [22.2 - 37.5]	30.9 ± 5.9 [19 - 47.3]
	Severe	29.2 ± 2.4 [25.7 - 31.2]	33.5 ± 6.2 [21.7 - 42.6]	29.8 ± 5.8 [22.2 - 37.5]	31.2 ± 5.7 [19 - 47.3]
	Total	29.2 ± 2.4 [25.7 - 31.2]	33.5 ± 6.2 [21.7 - 42.6]	29.8 ± 5.8 [18.3 - 37.2]	31.2 ± 5.7

Sig. p = 0.722

Table 14: Means and standard deviations for facial axis organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of Facial Axis (°) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	86.9 ± 4.9 [76.3 - 96.8]	87.1 ± 6 [78.3 - 97]	88.2 ± 5.8 [78 - 98.3]	87.3 ± 5.3 [76.3 - 98.2]
	Moderate	86.4 ± 4.6 [84.8 - 92.9]	86.3 ± 4.2 [79.8 - 95.7]	88.0 ± 6.0 [74.2 - 91]	86.9 ± 4.9 [74.2 - 95.7]
	Severe	89.6 ± 3.1 [84.8 - 92.9	86.9 ± 4.8 [79.8 - 95.7]	83.4 ± 4.6 [74.2 - 91]	86.0 ± 4.9 [74.2 - 95.7]
	Total	87 ± 4.7 [73.3 - 96.8]	86.8 ± 5 [78.3 - 97]	86.6 ± 5.8 [74.2- 98.3]	

Sig. p = 0.325

Table 15: Means and standard deviations for overbite (OB) organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of OB (mm) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	1.7 ± 2.5 [-4.3 - 8.9]	1.6 ± 2.0 [-2.5 - 5.1]	2.5 ± 2.3 [-2.4 - 7.4]	1.8 ± 2.3 [-4.3 - 8.9]
	Moderate	2.1 ± 2.0 [-1.9 0 6.3]	2.2 ± 2.4 [-2.4 - 5.4]	1.1 ± 1.7 [-2.5 - 2.8]	1.8 ± 2 [-2.5 - 6.3]
	Severe	2.5 ± 2.1 [-0.6 - 5.3]	3.6 ± 2.7 [-0.1 - 8.7]	0.9 ± 2.6 [-3.3 - 5.3]	2.3 ± 2.8 [-3.3 - 8.7]
	Total	1.9 ± 2.3 [-4.3 - 8.9]	2.4 ± 2.5 [-2.5 - 8.7]	1.6 ± 2.3 [-3.3 - 7.4]	

Sig. p = 0.171

Table 16: Means and standard deviations for tooth size discrepancy between molar to molar (TSD 6-6) organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of TSD 6-6 (%) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	91.8 ± 5.7 [61.8 - 101.4]	91 ± 2.6 [82.4 - 93.1]	93.1 ± 2.8 [90.8 - 102]	91.9 ± 4.6 [61.8 - 102]
	Moderate	93.1 ± 3.5 [90.1 - 106.4]	92.8 ± 1.7 [89.1 - 95.1]	92.5 ± 1.5 [89.8 - 95]	92.9 ± 2.5 [89.1 - 106.4]
	Severe	98 ± 6.1 [92.1 - 107.3]	92 ± 1.3 [90.2 - 94.6]	92.8 ± 2.2 [90.5 - 98.3]	93.4 ± 3.6 [90.2 - 107.3]
	Total	92.8 ± 5.4 [61.8 - 107.3]	91.8 ± 2.1 [82.4 - 95.1]	92.8 ± 2.2 [89.8 - 102]	

Sig. p = 0.052

Table 17: Means and standard deviations for tooth size discrepancy between cuspid to cuspid (TSD 3-3) organized by degree of crowding. Post-hoc pair-wise comparisons were conducted using Mann Whitney U with Bonferroni adjustments for multiple testing.

		Mean ± SD of TSD 3-3 (%) [Range]			
		Maxilla			
		Mild	**Moderate**	**Severe**	**Total**
Mandible	**Mild**	78.9 ± 3.5 [74.1 - 92.4]	77.9 ± 3 [70.5 - 85.1]	78.5 ± 1.3 [76.2 ± 81.6]	78.5 ± 3 [70.5 ± 92.4]
	Moderate	78.5 ± 2.5 [72.2 - 85.3]	78.2 ± 2 [74.2 - 80.5]	78.1 ± 2 [76 - 82.3]	78.3 ± 2.2 [73.2 - 85.3]
	Severe	81.7 ± 5.2 [78.2 - 90.2]	77.6 ± 1.8 [74.2 - 79.8]	77.7 ± 1.7 [74.1 - 79.7]	78.4 ± 3 [74.1 - 90.2]
	Total	79 ± 3.5 [73.2 - 92.4]	77.9 ± 2.3 [70.5 - 85.1]	78.1 ± 1.6 [74.1 - 82.3]	

Sig. p = 0.683